# Building Our Way To A More Sustainable Future

## Wellesley Green Collaborative, 2020

Stephanie Horowitz, AIA | ZeroEnergy Design

# CARBON
# MATTERS

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# MATTERS

# NOW!

ENERGY

ARCHITECTURE

# CHANGE THE CONVERSATION

ZeroEnergy DESIGN

HOME PORTFOLIO SERVICES FIRM BLOG CONTACT

## PORTFOLIO | ARCHITECTURE

DARTMOUTH OCEANFRONT HOME

Single Family Residence | 0.0kBtu/sf/yr

WELLFLEET MODERN HOUSE

Vacation Residence | 5.0kBtu/sf/yr

LEXINGTON MODERN RESIDENCE

Primary Residence | 10kBtu/sf/yr

MARGATE RESILIENT RESIDENCE

Single Family Residence | 9.3kBtu/sf/yr

PARKER POSITIVE MULTI-UNIT

8 Unit in 3 Multi-Family Bldgs | 0kBtu/sf/yr

SOUTHEND ROWHOME

2 Unit TownHome | 11kBtu/sf/yr

BROOKLINE MODERN RESIDENCE

Multi-Generation Residence | 23kBtu/sf/yr

LINCOLN NET POSITIVE FARMHOUSE

Net Positive Energy | -6.3kBtu/sf/yr

HILLSIDE CONTEMPORARY RESIDENCE

Single Family Primary Residence

FARMSTEAD PASSIVE HOUSE

Certified Passive House | 4.5kBtu/sf/yr

TRURO MODERN BEACH HOUSE

Multi-Generational Vacation | 11.2kBtu/sf/yr

WELLESLEY GREEN HOME

LEED Platinum Residence | 5.7kBtu/sf/yr

NEWTON NET ZERO RESIDENCE

Primary Residence | 0.4kBtu/sf/yr

POWISSET NET POSITIVE BARN

Net Positive Building | 0kBtu/sf/yr

NEEDHAM DEEP ENERGY RETROFIT

Primary Residence DER | -0.1kBtu/sf/yr

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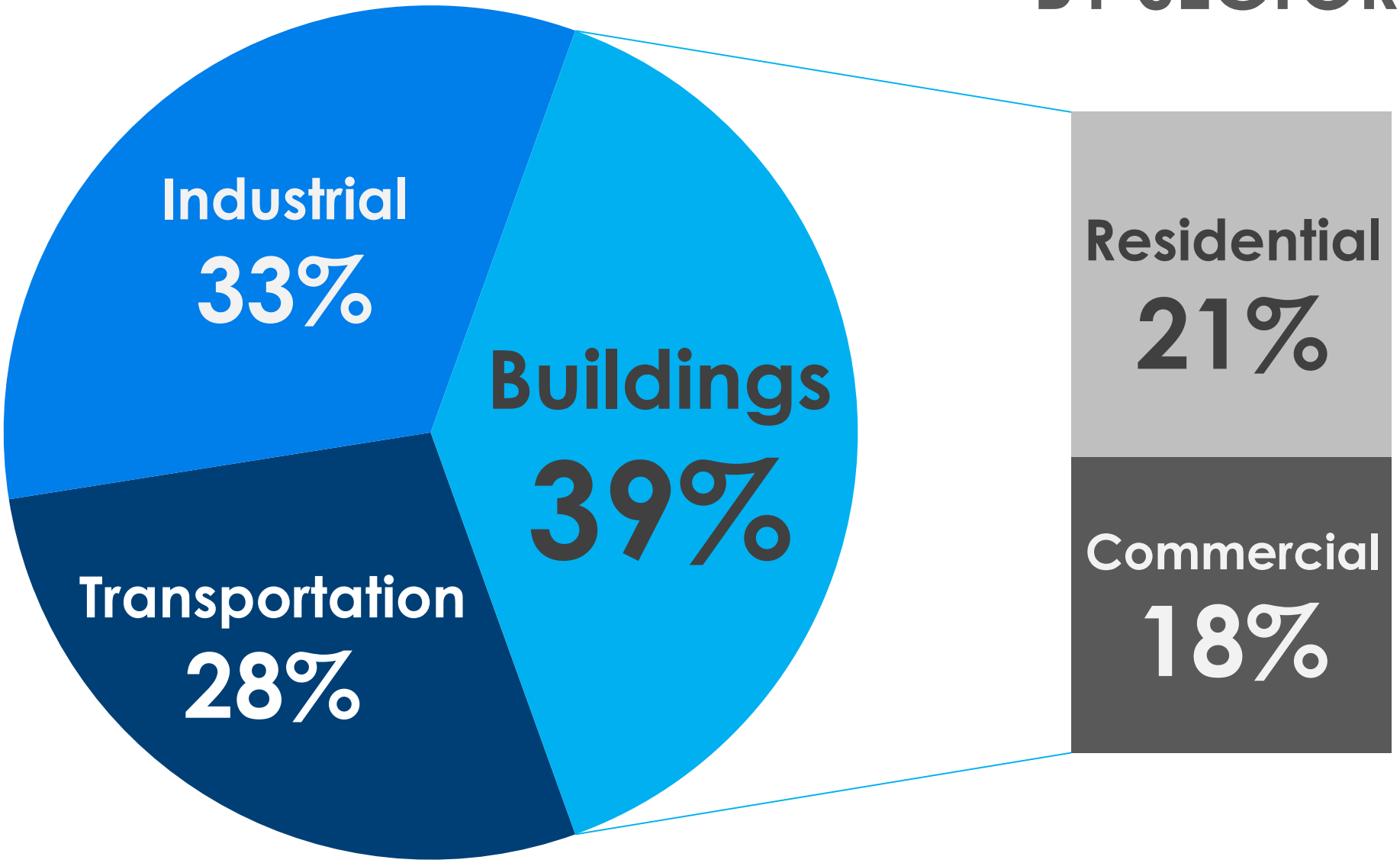
# WHERE DOES OUR ENERGY GO?

# US ENERGY USE

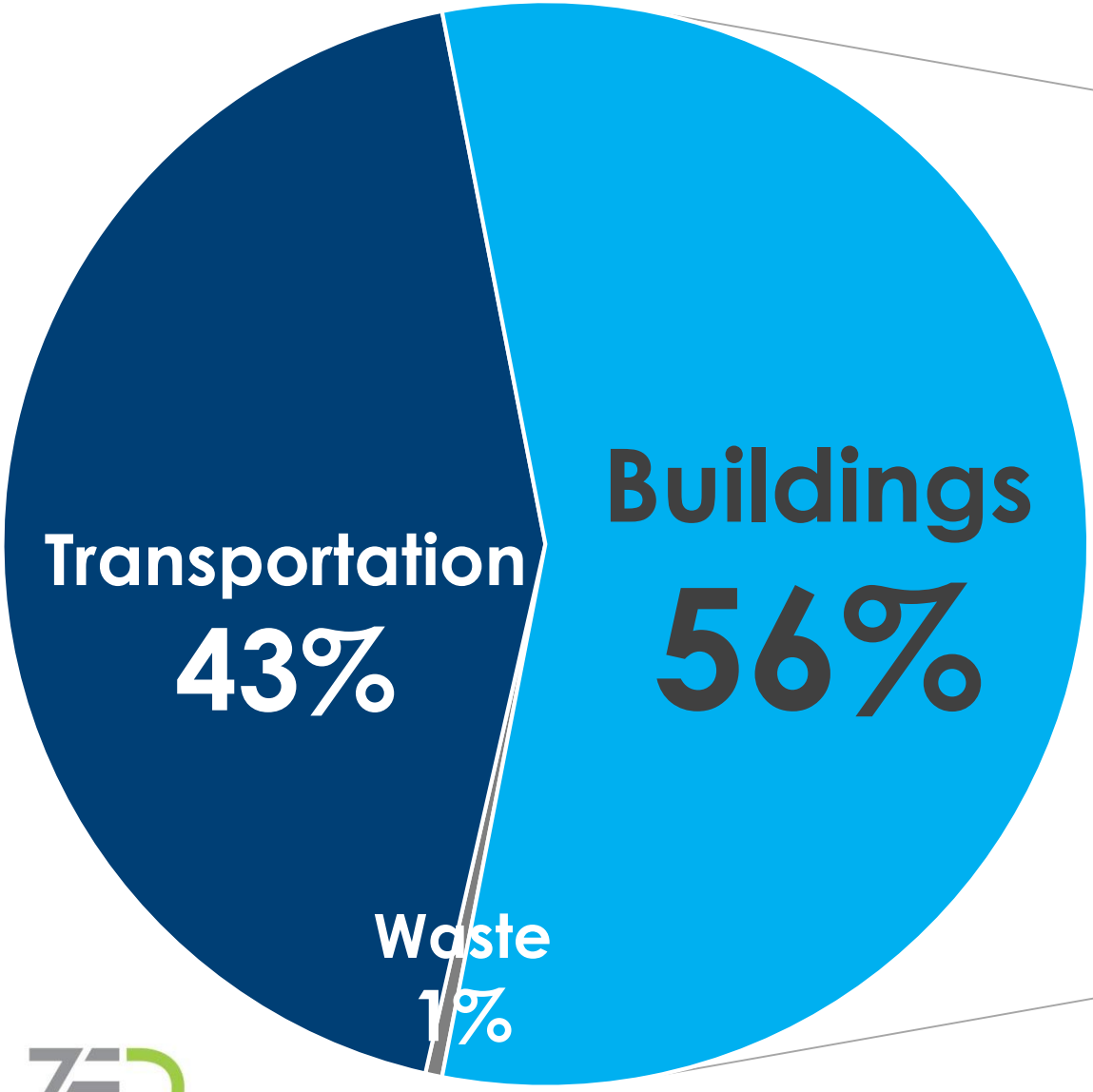
## BY SECTOR




SOURCE: US DEPARTMENT OF ENERGY, 2018

# WELLESLEY GHG EMISSIONS

## BY SECTOR




Residential
31%

Commercial
13%

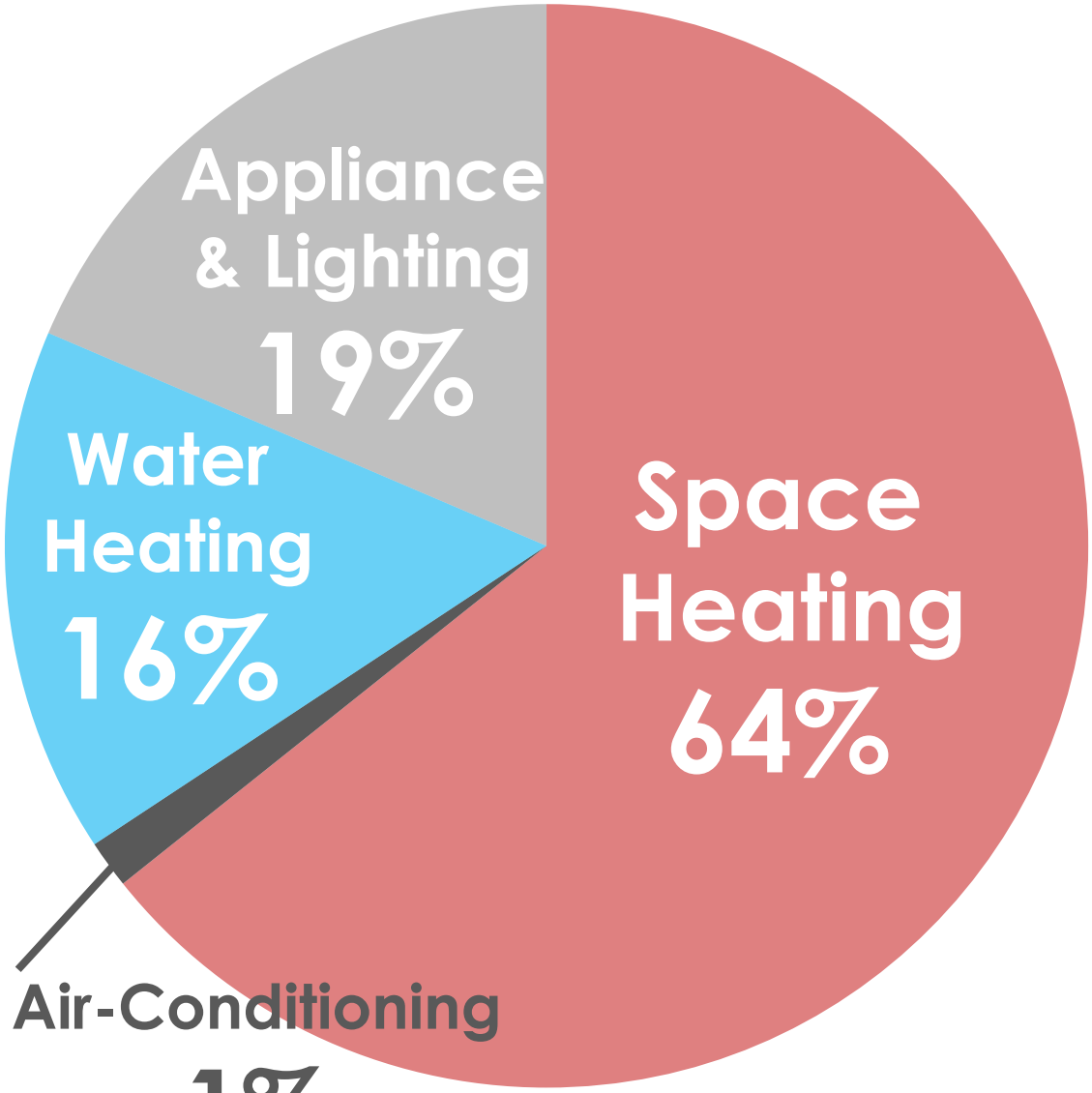
Colleges
11%

Municipal
2%

SOURCE: Wellesley SEC, 2018

# NE ENERGY CONSUMPTION

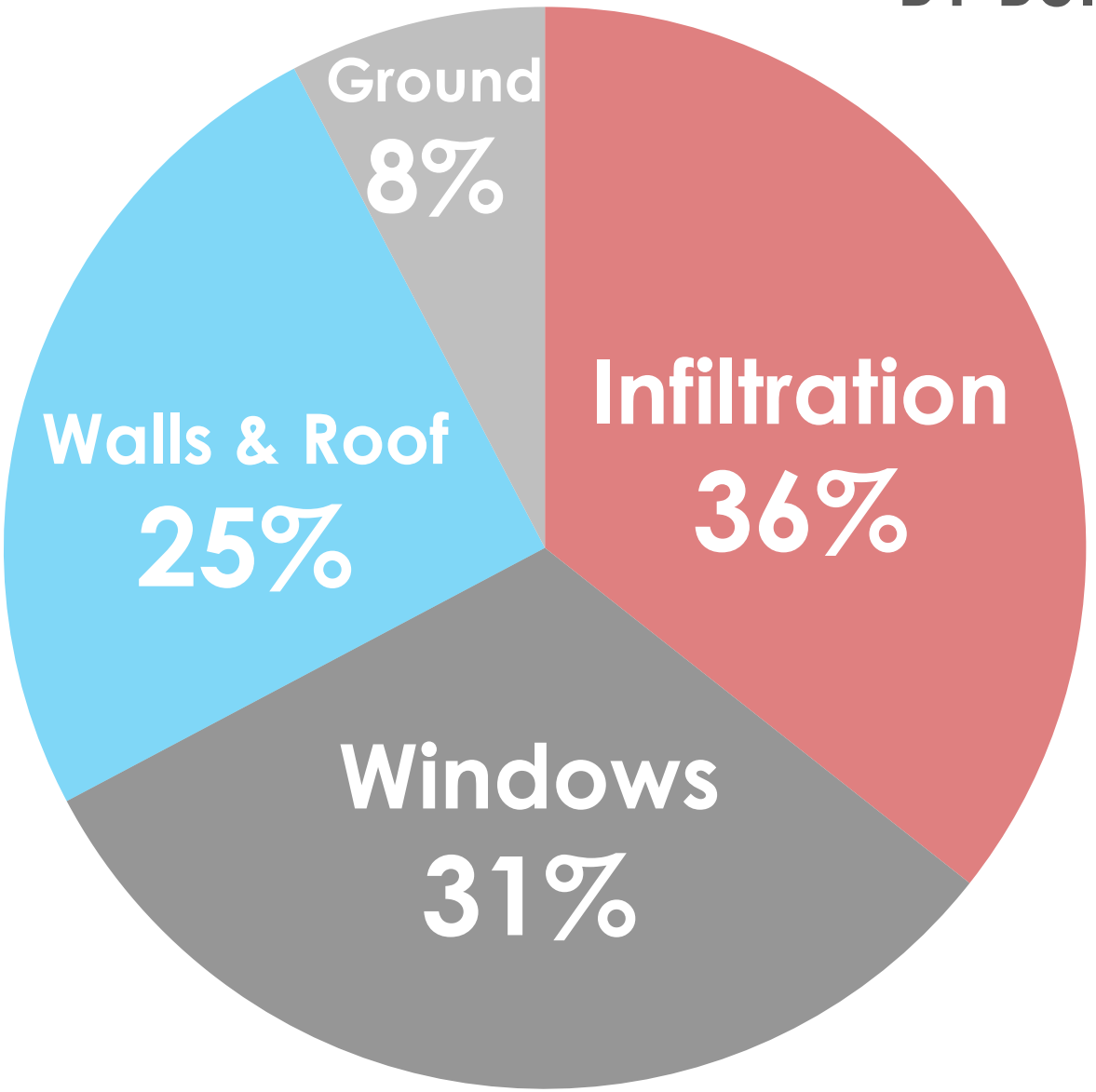
## BY END USE




*Source: US Energy Information Agency Residential Energy Consumption Survey, 2005*

# TYPICAL HEAT LOSS

## BY BUILDING COMPONENT




SOURCE: ZeroEnergy.com

ENERGY

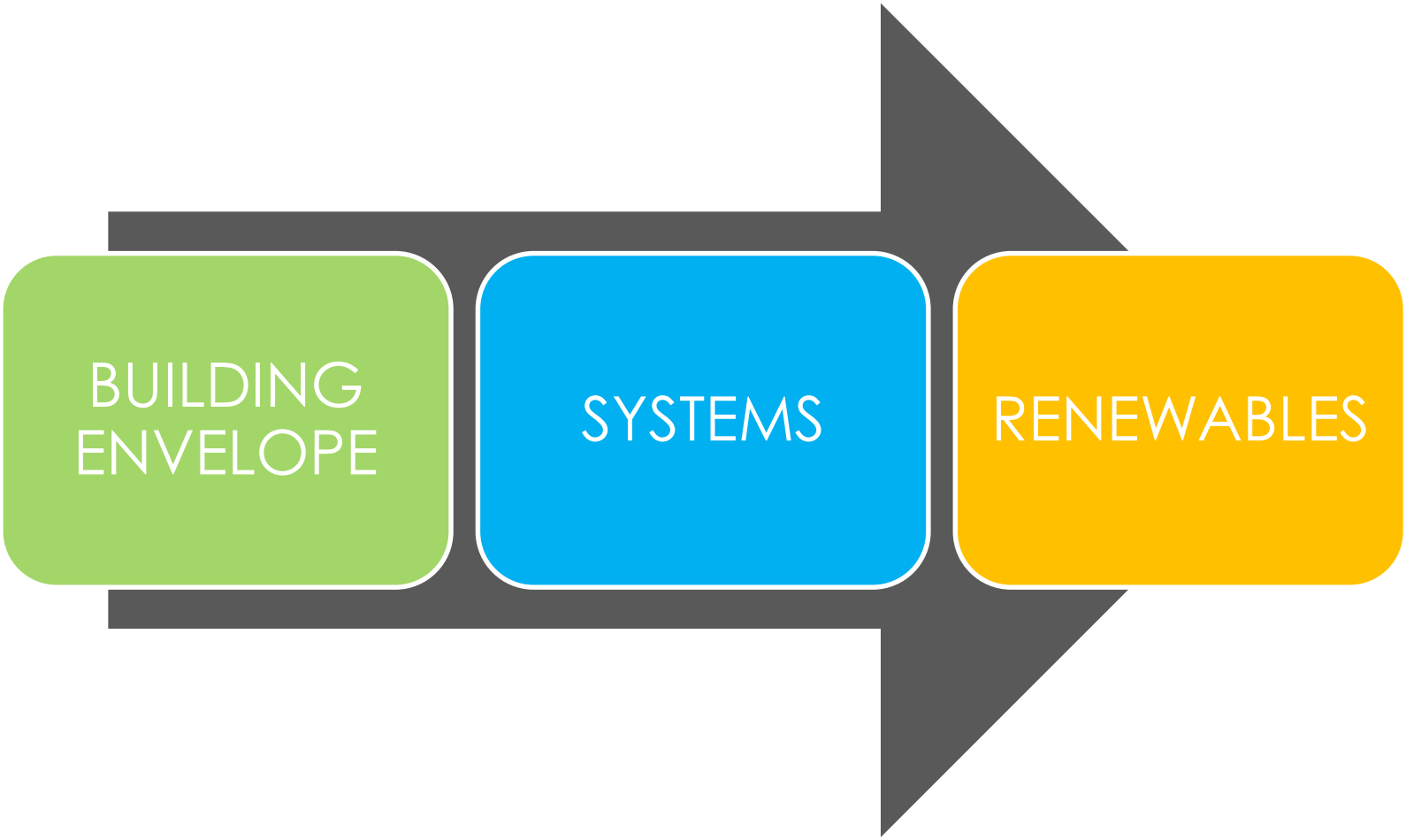
DURABILITY

GREAT DESIGN

HEALTH

COMFORT

# DESIGN & FOLLOW THE PATH TO ZERO



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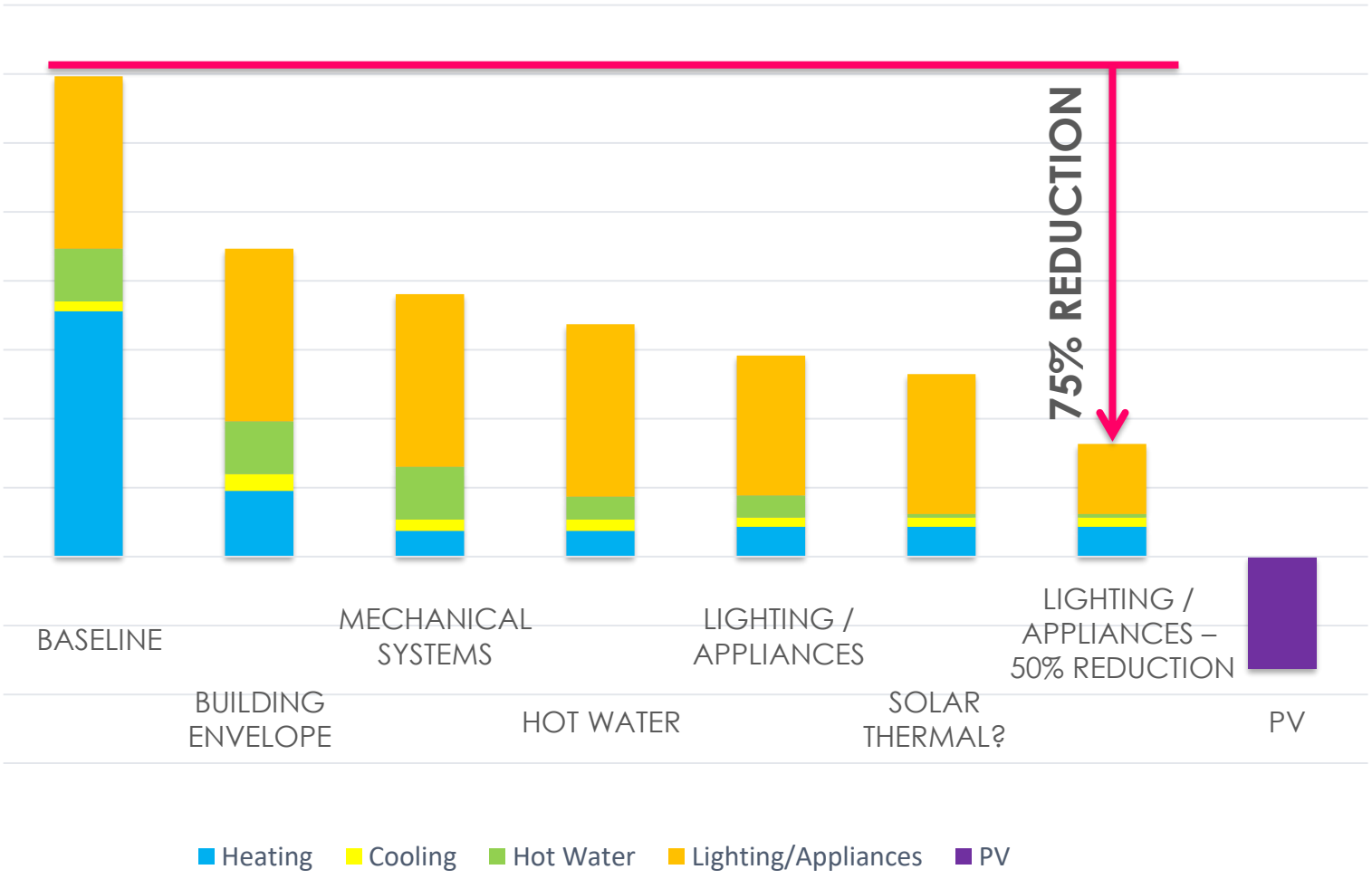


CREDIT: Chuck Choi


LINCOLN FARMHOUSE
CREDIT: Chuck Choi

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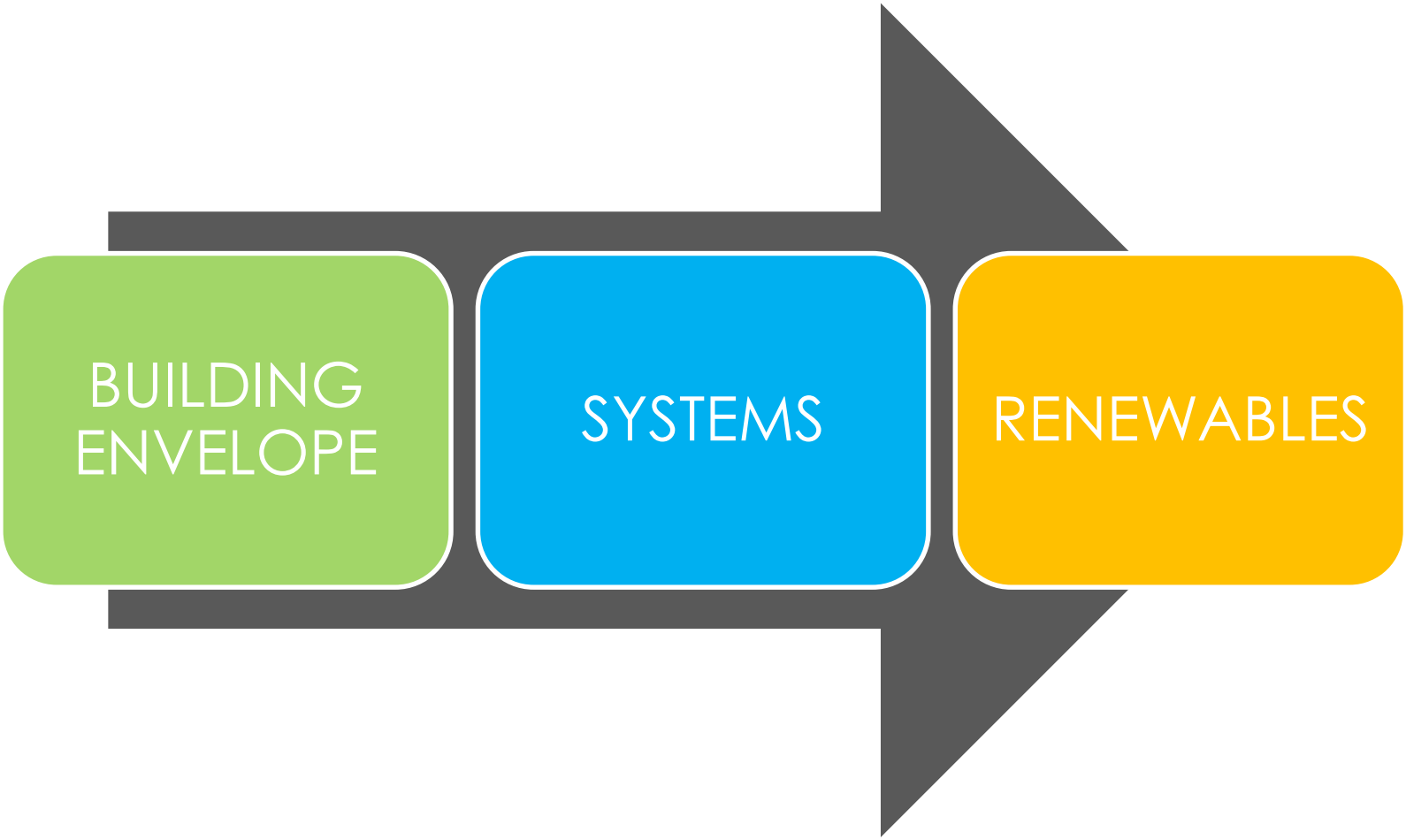


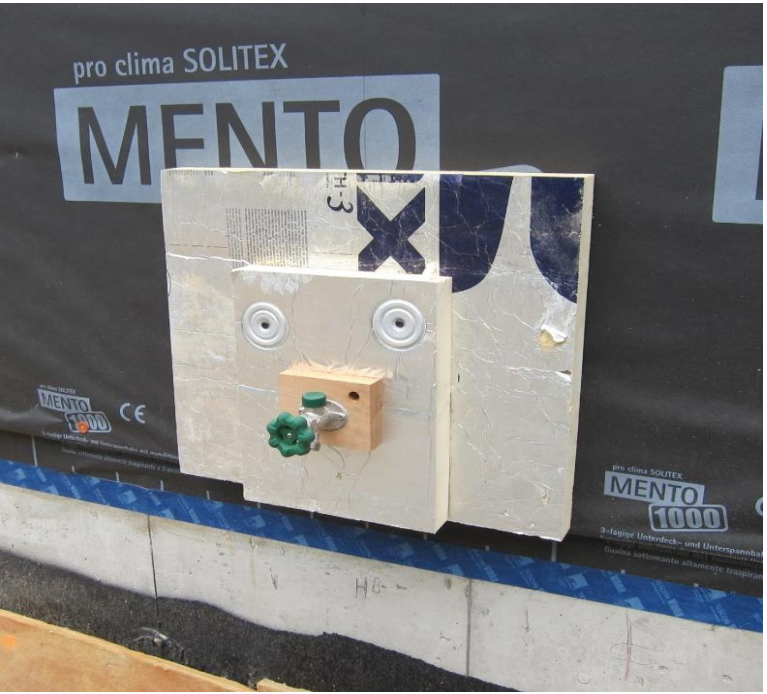
# STRATEGIES THAT WE LIKE

- Start with design
- Continuous air barriers
- Continuous insulation
- Insulation with low GWP
- Triple-glazed windows
- Air-source heat pumps
- Continuous ventilation w/ E. recovery
- Renewables


MENTO 1000


INTELLO®
CE
iab
100X

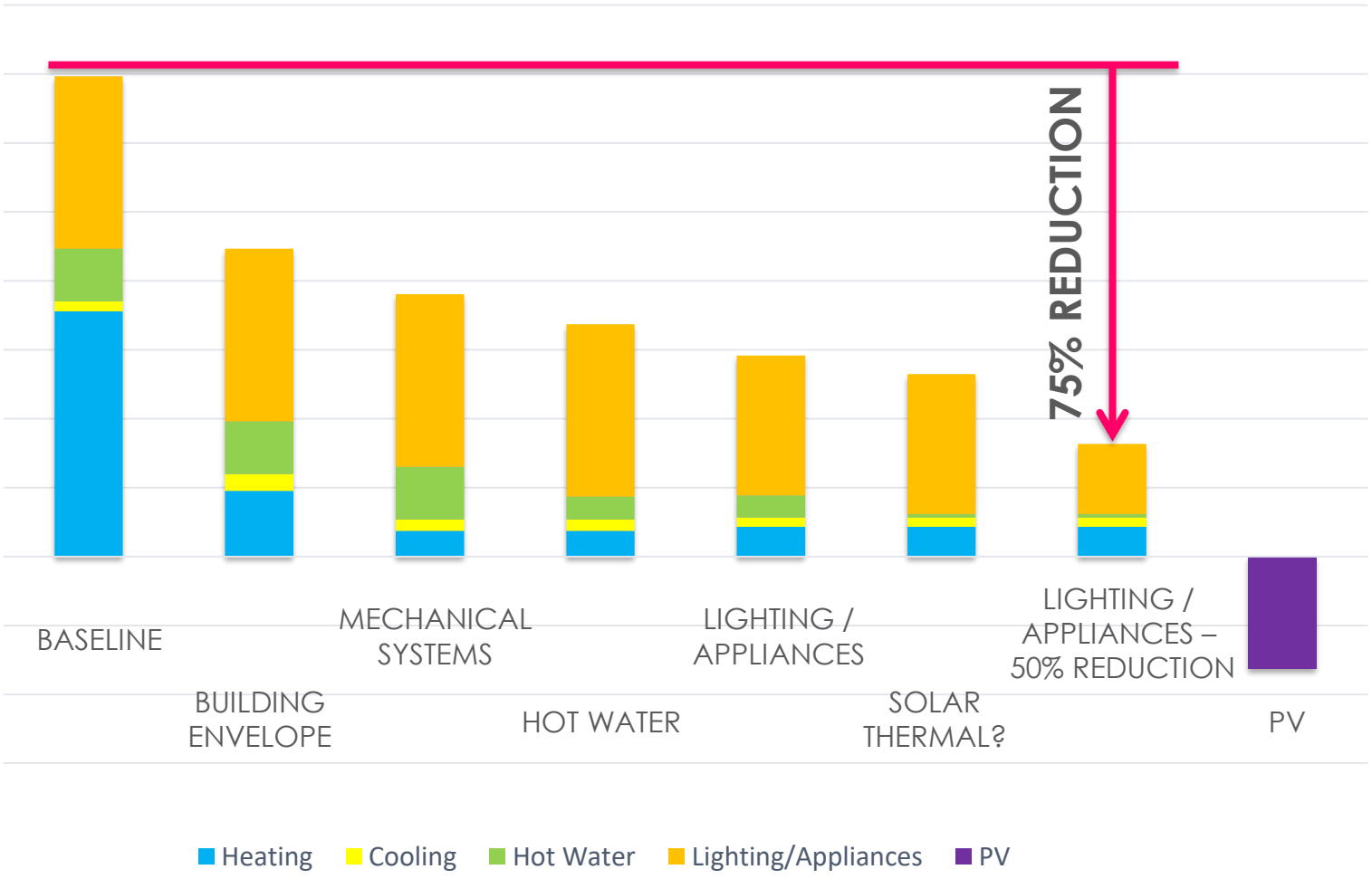

300


pro clima SOLITEX
MENTO
MENTO 1000
pro clima SOLITEX
MENTO 1000

Credit: Agepan

Credit: Energia

# THE PATH TO ZERO

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# LINCOLN FARMHOUSE

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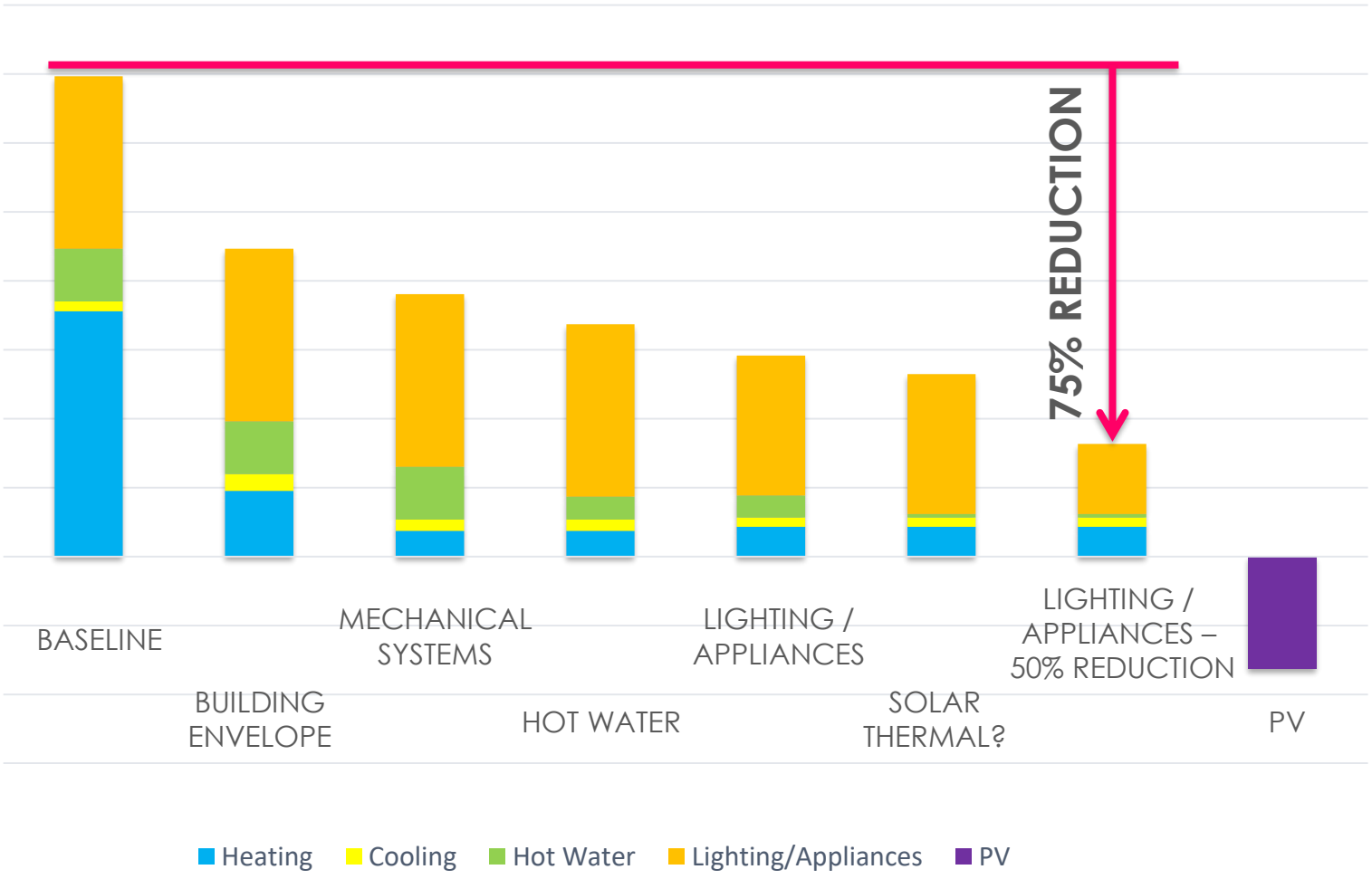
# THE PATH TO ZERO - RENOVATIONS



# LINCOLN FARMHOUSE

CREDIT: Chuck Choi

# BUILDING ENVELOPE STRATEGIES

**Slab**

- 4" concrete slab + 6" type IX EPS
- R-26

**Below Grade Wall**

- 10" concrete wall + 4" polyiso + 2x4 w/ batt
- R-36

**Above Grade Wall**

- 2x6" w/dense-packed cellulose (DPC) + 4" polyiso
- R-44

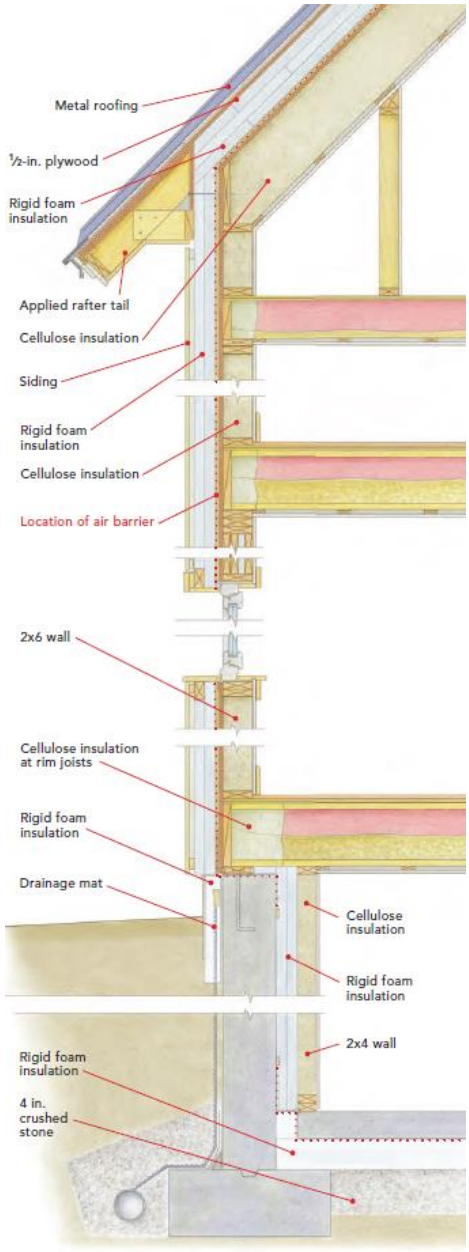
**Roof**

- 2x10 w/DPC + 6" polyiso
- R-69

**Windows**

- Wood-clad triple paned tilt/turn windows
- U-0.15; SHGC-0.32

**Continuous Air Barrier**



# BUILDING ENVELOPE STRATEGIES



# SYSTEMS

- Heating/Cooling
  - Mitsubishi air-source heat pump (non-Hyperheat)

- Domestic Hot Water
  - Steibel-Eltron heat pump hot water tank

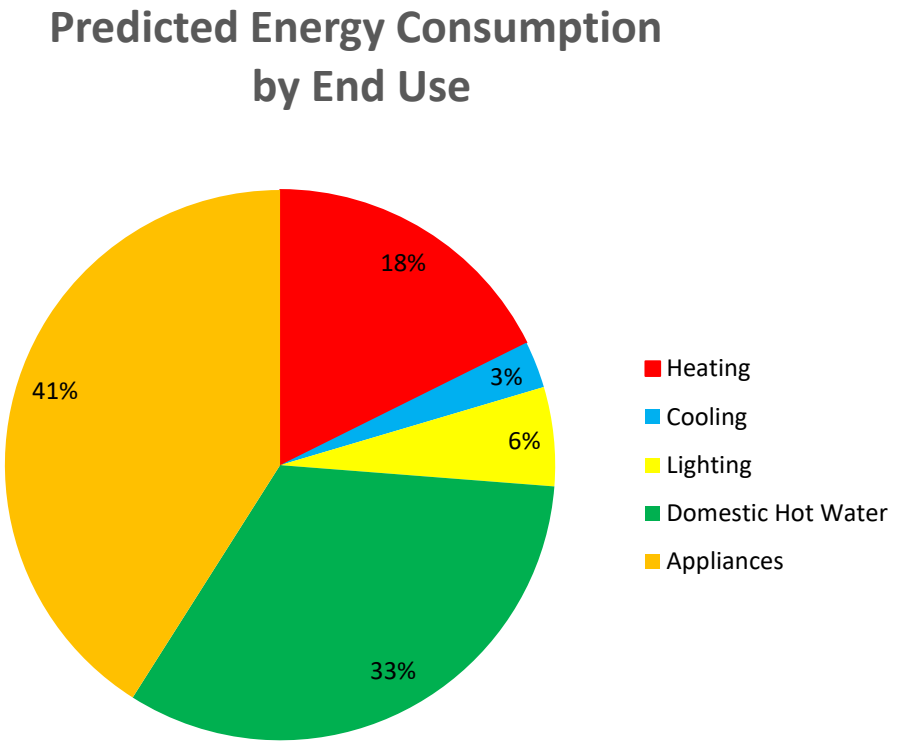
- Ventilation
  - Zehnder ERV

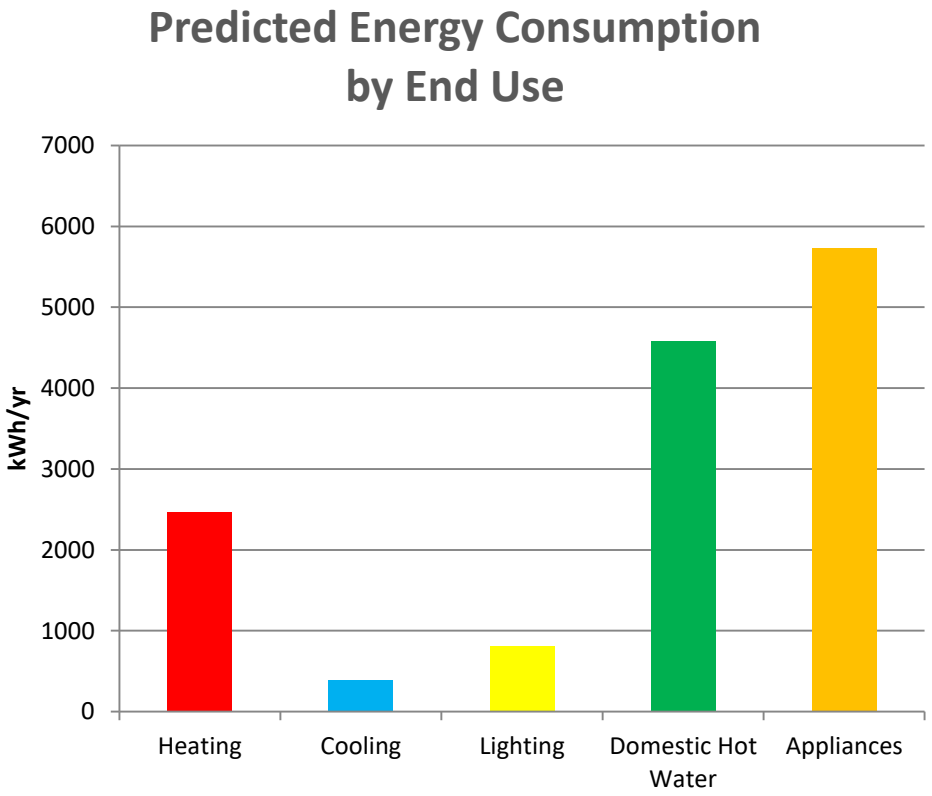
# RENEWABLE ENERGY

  - 13.1 kW photovoltaic array


- 0.27 ACH50
- IECC 2012 – 3.0 ACH50
- >90% reduction

# MODELED RESULTS




- Total: 14,000 kWh/yr (10.9 kbtu/ft$^2$ EUI)
- 11.2 kW of photovoltaics to achieve Net-Zero Energy performance

Powerhouse Dynamics

Welcome, Mark (Home) Not Mark?

Settings | Support | Log Out

HOME | Circuits | Alerts | Ways to Save | Report Card | Local Weather

SiteSage Status:

Current use: 0.29 kW | $0/hr

Outside Temp: 42°F

Share My SiteSage Window

## Utility Meter


291w
Power Usage Now

## Power Production


## Top Appliances/Circuits On Now

- Refrigerator (91w)
- A/C Condensing unit (37w)
- Unmonitored Power (35w)
- AV CATV Equipment (32w)
- ERV (26w)
- Office (23w)
- Family room receptacles[1... (9w)
- PV DAS (7w)
- Garage Receptacles (7w)

## 30-Day Carbon Footprint

| MA Aug. | My $CO_2$ |
|---|---|
| 573 lbs. | 0 lbs. |

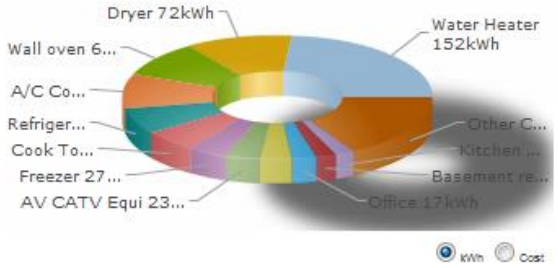
30-Day Phantom Power $6

## Sensors

| | |
|---|---|
| Temp | 76°F |
| CO2 | 590 ppm |
| Humidity | 44% |

## Where I've used electricity in the past 30 days: Top 12 Circuits

Click a slice or label for detail / View All Circuits




kWh Cost

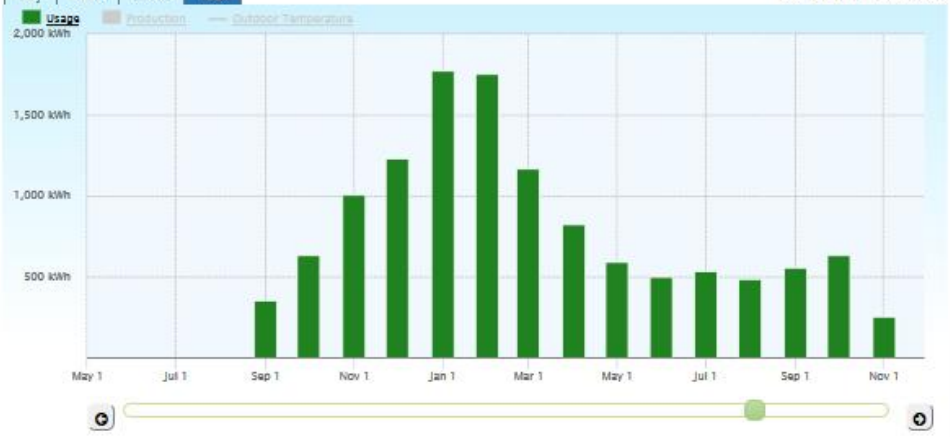
## Electricity Usage in kWh by Month


## Top 4 Users by kWh - Last 30 days

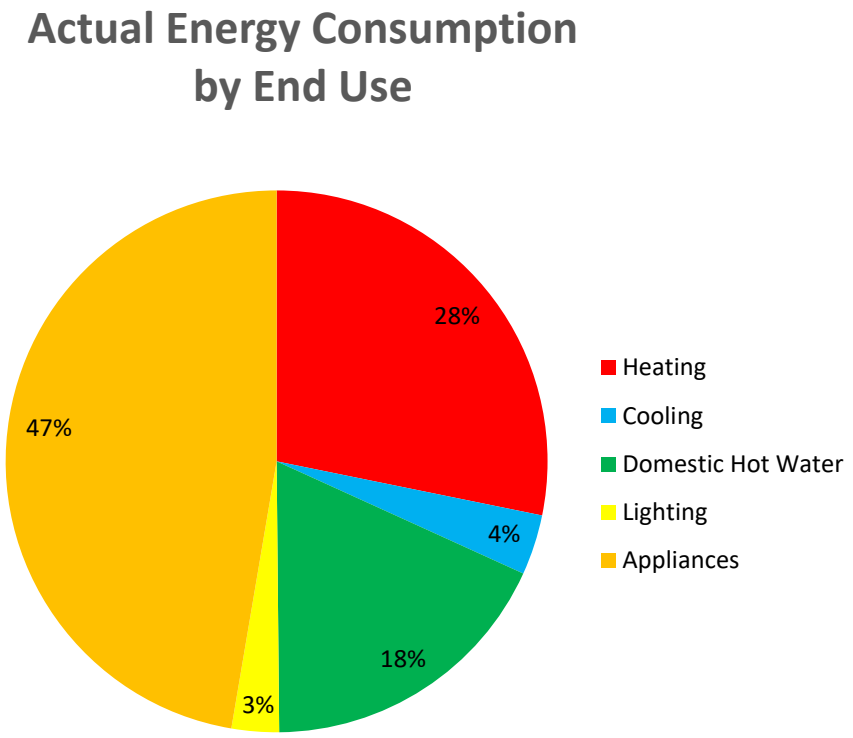

kWh | $ Cost | Line | Column

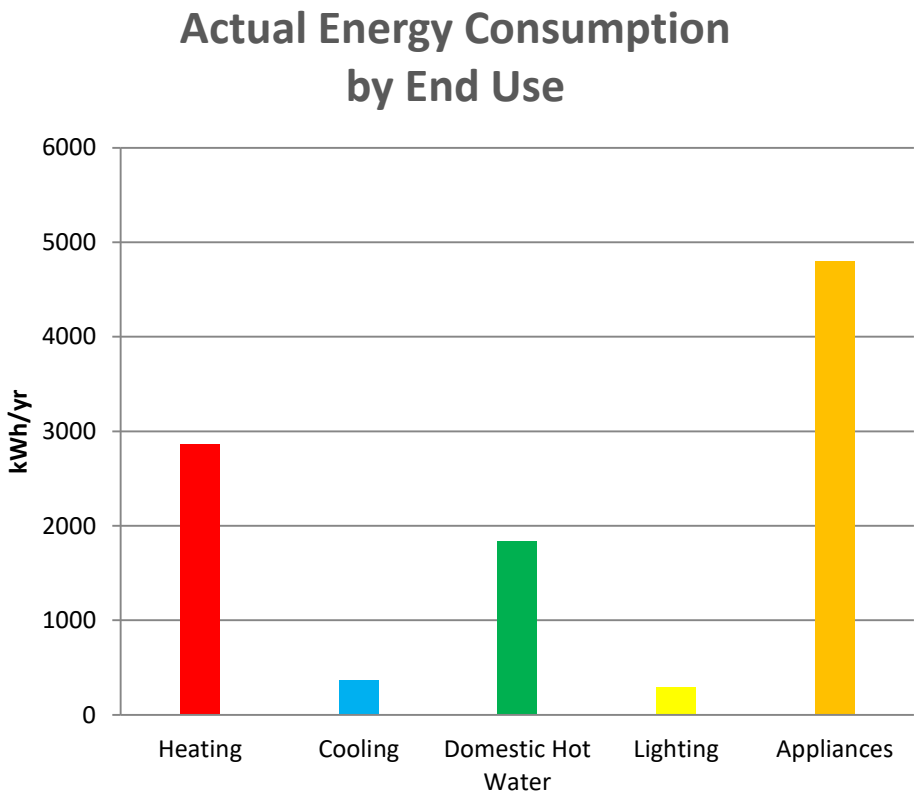
Day | Week | Month | Year

05/14/2014 - 11/14/2015



# ACTUAL RESULTS

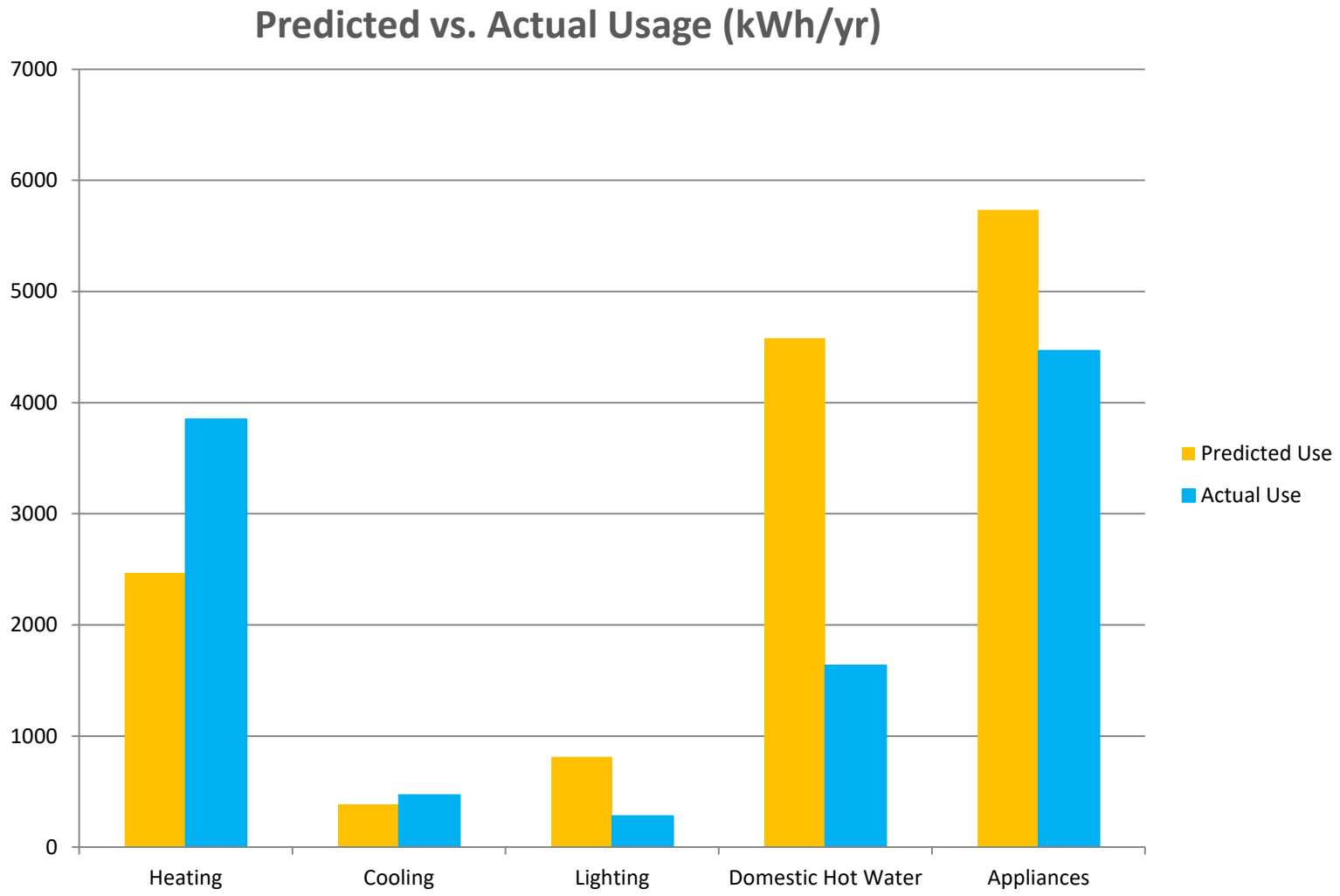



- Total: 10,174 kWh/yr
- 3,800 kWh/yr less than predicted

Source: ZeroEnergy Design

# PREDICTED VS. ACTUAL RESULTS



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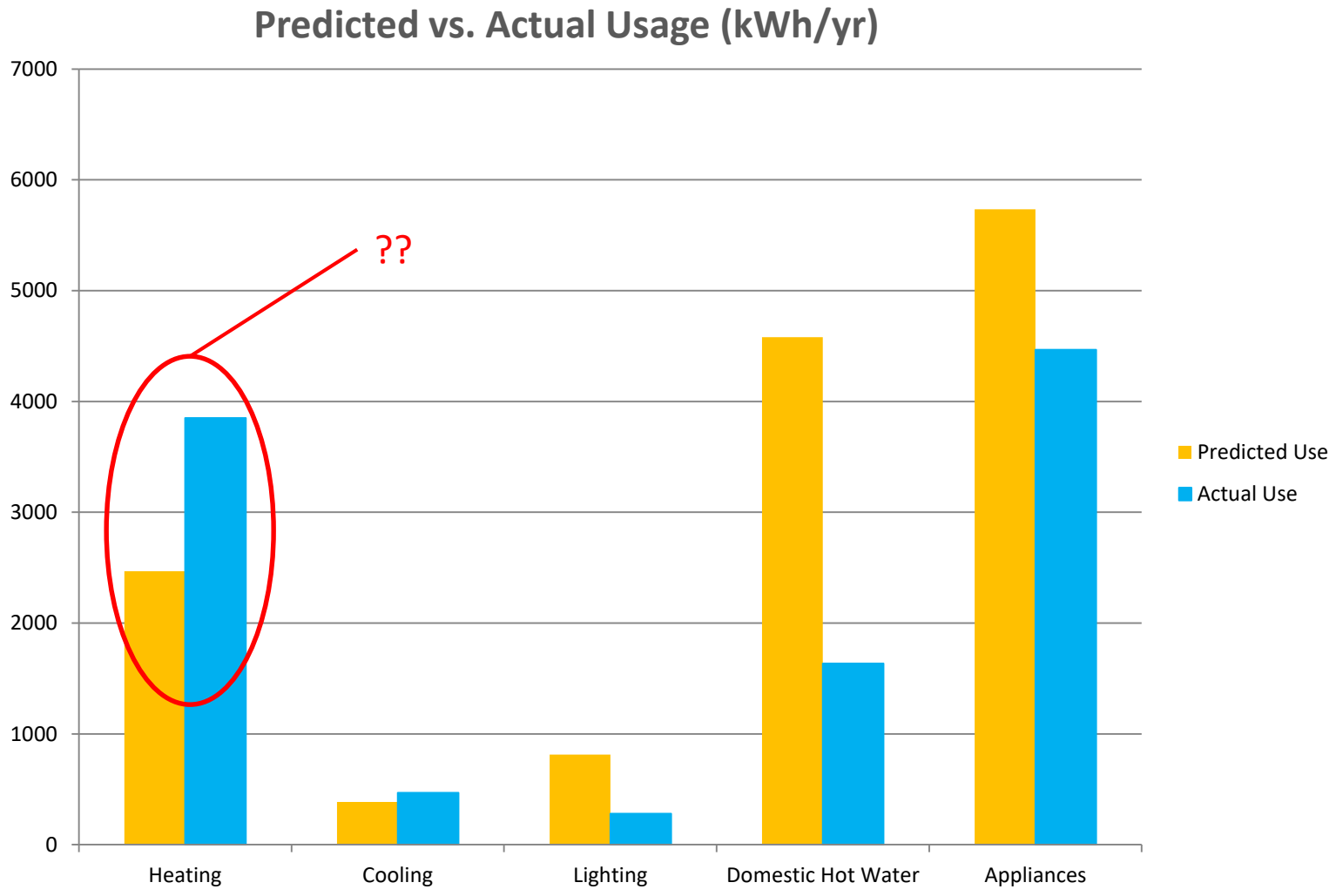
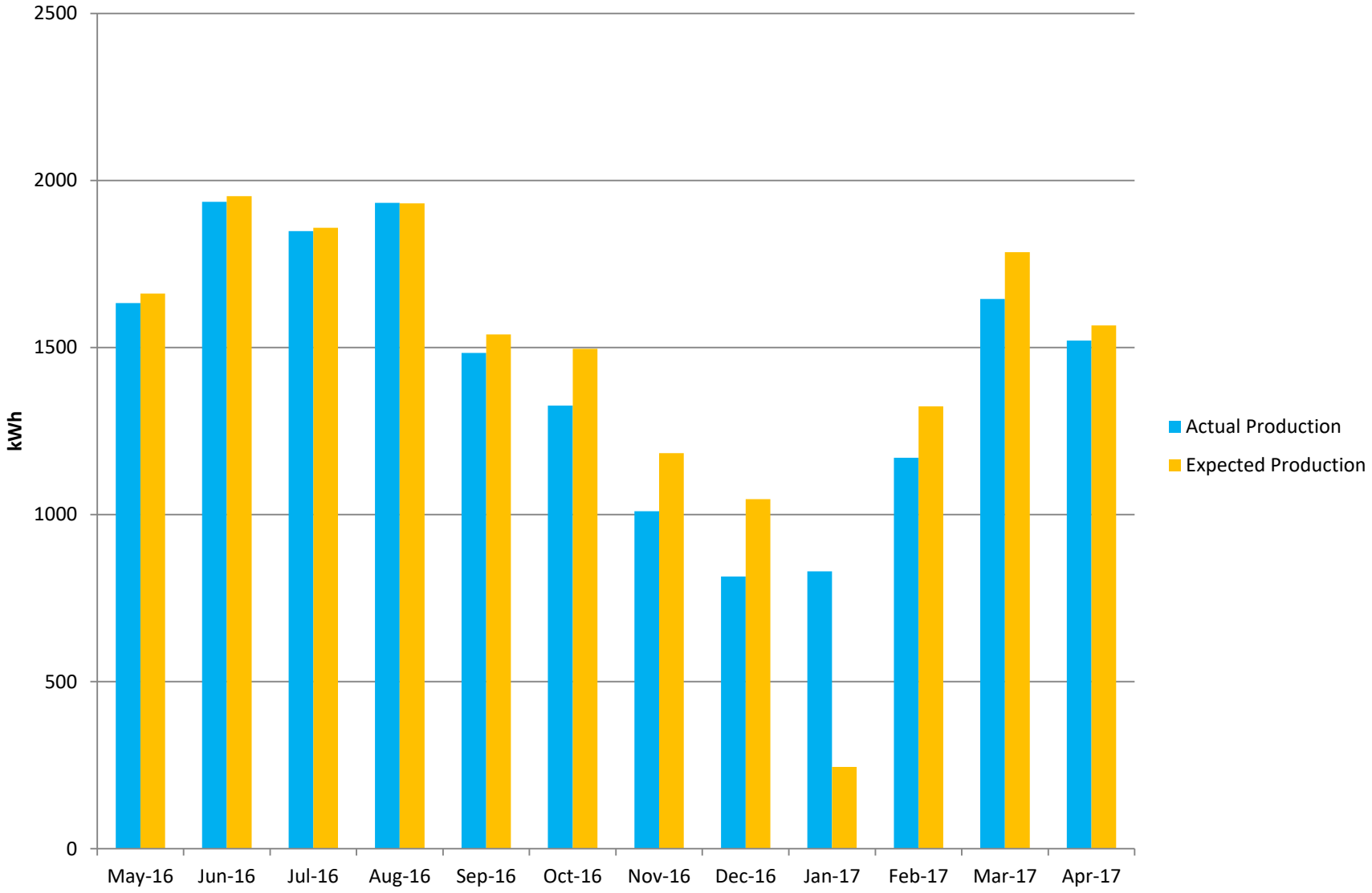


# WHY IS HEATING 60% HIGHER THAN EXPECTED

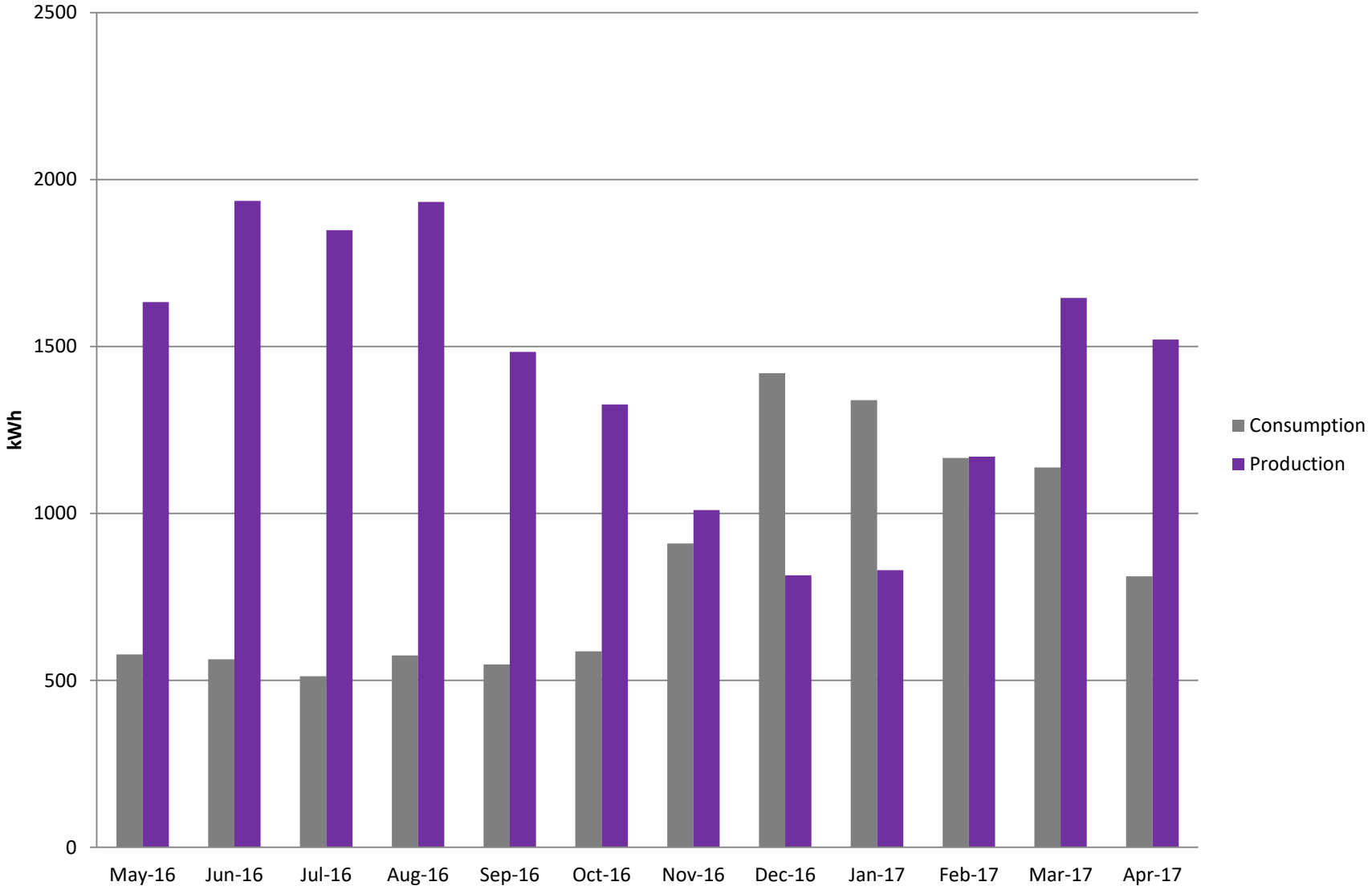
- Much colder than average winter
  - 35% more heating degree days (7873 vs 5848)

- Heat pump is operating at very low outdoor temps for many hours (least efficient operating point)

# ACTUAL vs. EXPECTED PV PRODUCTION



# MONTHLY ENERGY CONSUMPTION AND PRODUCTION




Source: ZeroEnergy Design

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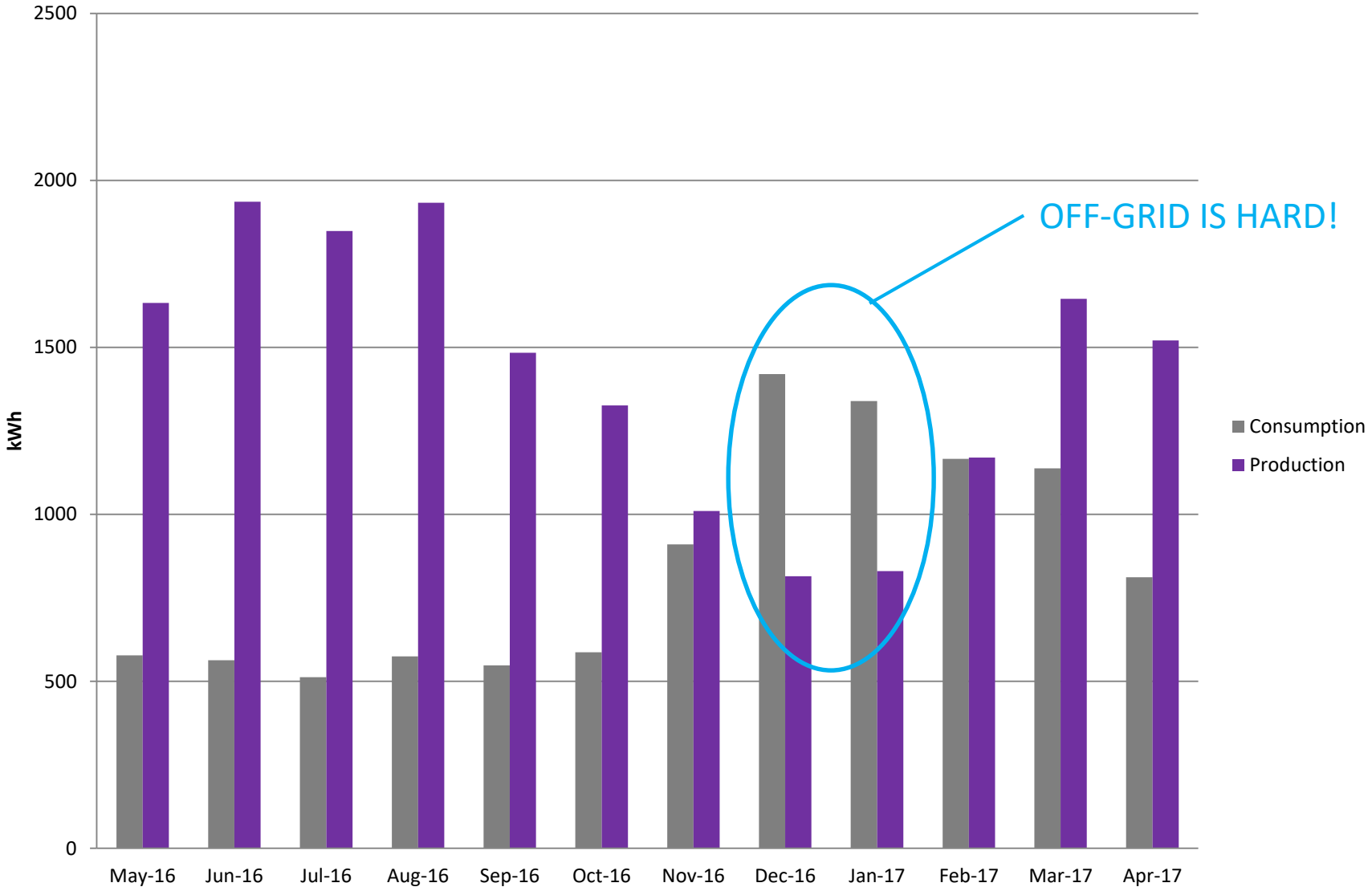


# ACTUAL RESULTS SUMMARY

- **10,146 kWh total consumption**

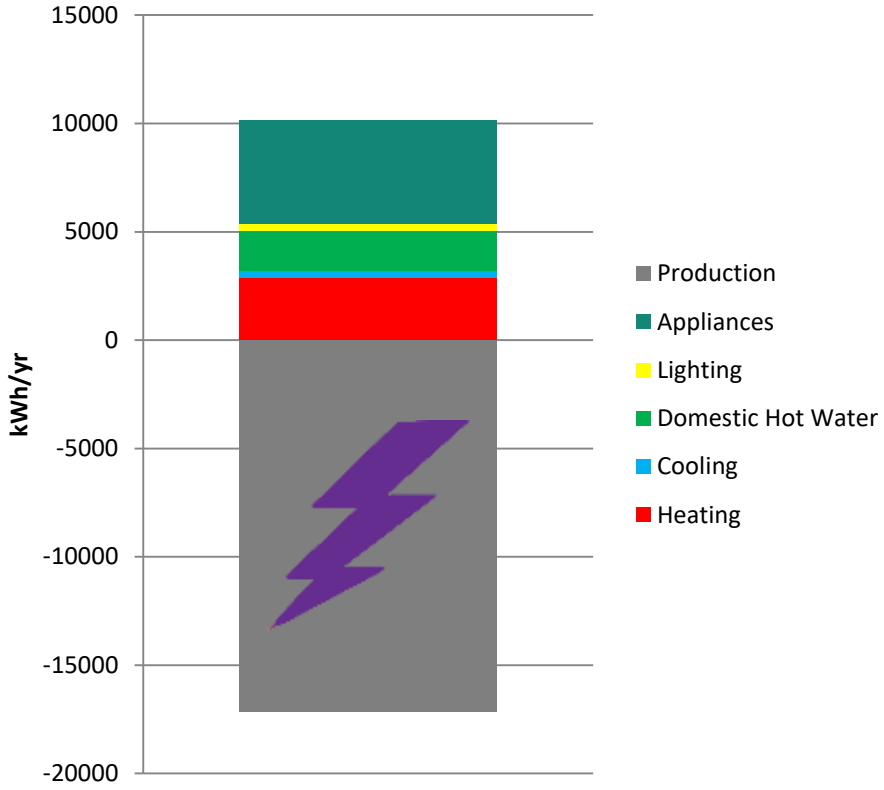
  (7.9 kbtu/ft2 EUI)

- **17,151 kWh total production**

  (1243 kWh/kW)

- **7,005 kWh net surplus**

  Equivalent to 18,000-30,000 electric car miles

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